THE EMBRYOLOGY OF OXALIS CORNICULATA.*

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Oxalis corniculata might be called a sub-tropical plant although it is frequently found growing in ballast about the Eastern seaport towns of the United States and becomes quite abundant in Texas. In tropical America it is quite common and is also reported as occurring in the tropical regions of the Old World. It has been reported as far north as Ontario. Frequently it is found growing on the ground in greenhouses where it blooms profusely throughout the year. It was under these last named conditions that the writer secured the material with which he worked. The material was collected throughout the Spring of 1906 and the Fall and Winter of 1906–1907. The usual methods of killing and imbedding were used. The sections were cut 8 mic. thick and stained on the slide. Delafield's Haemotoxylin proved the most satisfactory stain. To Prof. John H. Schaffner under whose direction this study was begun and to Prof. Robert F. Griggs under whom the study was completed I desire to express my sincere thanks for their kind assistance and suggestions.

MEGASPORES AND EMBRYO SAC.

The nucellus consists of a single axial row of cells invested by the epidermis (Fig. 1). The uppermost cell of the axial row is the archesporium which, thus appearing very early, increases to two or three times its original size. It does not give rise to parietal tissue but undergoes directly the Reduction Division which was not observed (Fig. 2). The lowest of the three or four megaspores thus formed becomes the functional one, and rapidly enlarges at the expense of the potential ones above, giving rise to the two (Fig. 3), four (Fig. 4), and eight (Fig. 6), celled embryo sacs in the usual manner. Before the two celled embryo sac is formed the surrounding epidermis which functions as tapetum, has begun to disintegrate and the sac is subsequently enclosed simply by the integuments. The embryo sac develops very rapidly and is nearly straight although the ovule is anatropous. The antipodals are small, stain darker than the polar nuclei or the unfertilized egg, and begin to disintegrate at the time of the conjugation of the polar nuclei (Fig. 6), sometimes disappearing before fertilization in case that is delayed till after the polar nuclei have fused (Fig. 5). The synergids stain dark, are rather large, and also disintegrate early, one of them being destroyed by the entrance of the pollen tube (Fig. 6).

ENDOSPERM AND EMBRYO.

Connecting the endosperm cells are radiations, as has been frequently observed in many plants, but these are not kino-

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plasmic in appearance but rather consist of a radial arrangement of ordinary cytoplasm. They do not lead to cell formation although a small amount of endosperm persists until the seed is nearly mature.

After fertilization the egg elongates and forms a pro-embryo four cells in length. There seems to be a more or less constant transverse division in the second cell of the pro-embryo, thus foreshadowing the massive suspensor (Figs. 8 and 9). The two suspensor cells thus formed by division together with the basal cell flatten against the wall of the integuments and give a foot-like appearance to the base of the suspensor, and form a haustorium like organ which maintains its activity, judging by its staining reaction, till the embryo is mature, although the upper cells of the suspensor may begin to break down before that time (Figs. 10, 12, 16 and 17). This organ burrows its way into the integuments until it reaches the testa forming a ball of tissue which may, apparently from the division of the original three, consist of a number of cells. The third cell of the pro-embyro probably forms the remainder of the suspensor consisting usually of three tiers containing one or two rows of cells (Figs. 13–16). The suspensor is rather short, forms no part of the embryo, has no hypophysis as has long been known for Geranium,* nor does it form the rootcap. As the embryo matures the dermatogen and calyptrogen are extended around the tip of the hypocotyl. The calyptrogen and calyptra are differentiated from this in the usual way. With advanced growth they completely surround the hypocotyl and form the root cap (Figs. 15 and 16), which is for a time distinctly concave at its junction with the suspensor till that organ disintegrates and disappears. With this exception, the general development of the embryo is similar to the Capsella type. The cotyledons arise from the opposite points of the almost spherical embryo in the usual dicotyl manner with the plumule between them.

SUMMARY.

1. The archesporium is a single sub-epidermal cell and becomes the functional megaspore directly without forming parietal tissue.
2. The whole nucellus functions as tapetum.
3. The antipodals and synergids disappear soon after fertilization.
4. The embryo forms no hypophysis.
5. A multicellular haustorium-like organ is formed from the basal cells of the suspensor which forces its way through the integuments until it reaches the testa.

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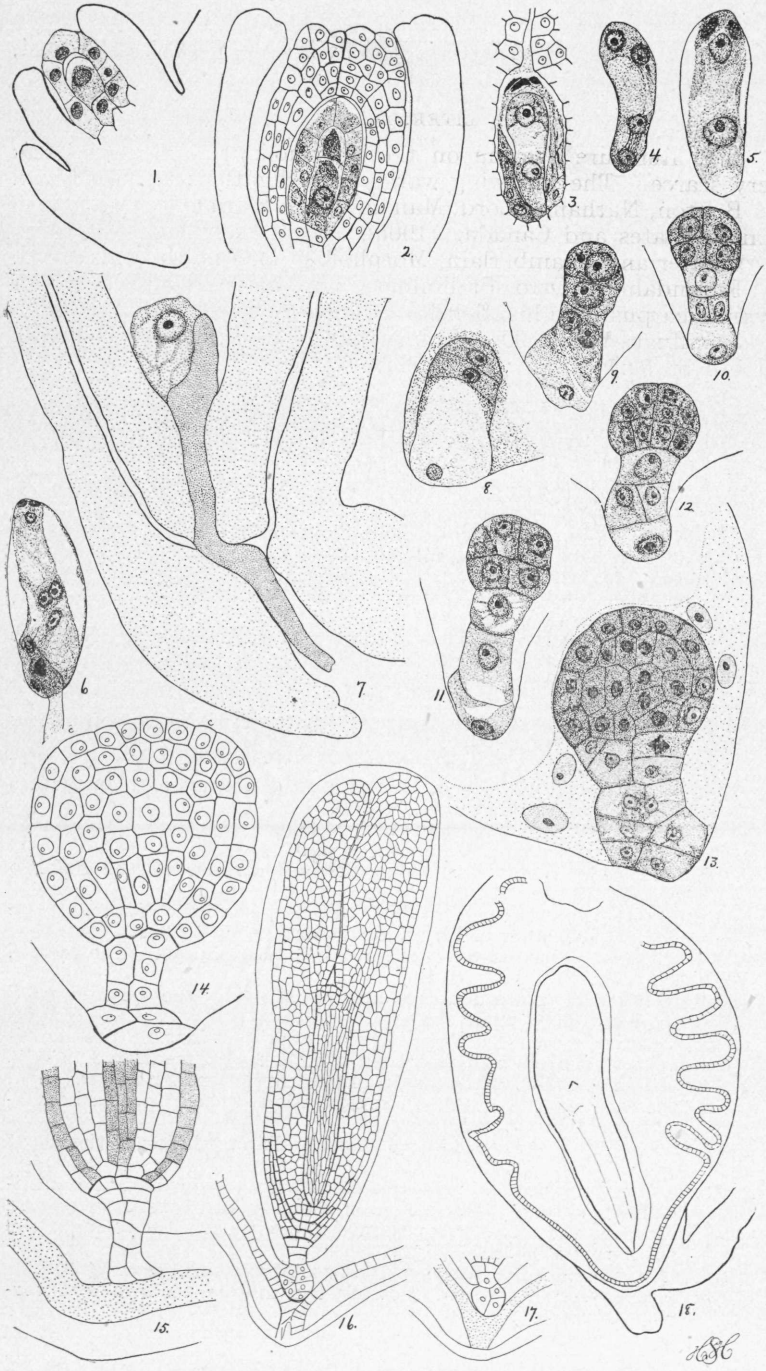
* Coulter and Chamberlain, Morphology of Angiosperms. 200. 1903.



HAMMOND on "Oxalis Corniculata"

LITERATURE.

The literature bearing on the morphology of Geraniales is very scarce. The following works bear slightly on the subject.

Britton, Nathaniel Lord, Manual of the Flora of the Northern United States and Canada. 1905.

Coulter and Chamberlain, Morphology of Angiosperms. 1903.

Rosendahl, C. Otto, Preliminary note on the Embryogeny of Symphocarpus foetidus, Salisb. Science N. S. 23: 590. 1906.

Schaffner, Mabel, The Embryology of the Shepherd's Purse. Ohio Nat. 7 : 1–8, pls. 1–3, 1906.

EXPLANATION OF PLATES.

All drawings were made with a Bausch and Lomb microscope with the aid of a camera lucida. In reproduction they were reduced to one-third their original size. The following combinations of oculars and objectives were used:

Figs. 1–14, oc. ½ in., obj. 1-6 in. Magnification 720.
Fig. 15, oc. 2 in., obj. 1-12 in. Magnification 470.
Figs., 16 and 17, oc. 2 in., obj. 1-6 in. Magnification 205.
Fig. 18, oc. ½ in., obj. 2-3 in. Magnification 146.

Fig. 1. Young ovule with archesporial cell. × 360.
Fig. 2. Large megaspore with non-functional ones above it. Nucellus beginning to disintegrate. × 360.
Fig. 3. Two celled embryo sac. × 360.
Fig. 4. Four celled embryo sac. × 360.
Fig. 5. Seven celled embryo sac with the antipodals completely disintegrated. × 360.
Fig. 6. Eight celled embryo sac showing entrance of pollen tube hiding disintegrating synergid. Polar nuclei uniting and antipodals beginning to disintegrate. × 360.
Fig. 7. Fertilized egg and pollen tube. × 360.
Fig. 8. The three celled pro-embryo. × 360.
Fig. 9. Six celled embryo showing first appearance of the embryo proper. × 360.
Fig. 10. Young embryo showing the octant stage and the division of the central suspensor cell by a longitudinal wall. × 360.
Fig. 11. Slightly older stage in the growth of the embryo. The central suspensor cell undivided. × 360.
Fig. 12. Somewhat more mature embryo showing the beginning of dermatogen. × 360.
Fig. 13. More advanced embryo showing the beginning of the multicellular suspensor, dermatogen completely differentiated. × 360.
Fig. 14. Embryo showing the origin of the cotyledons by the bulge on the opposite sides. Foot-like expansion of the suspensor becoming prominent. × 360.
Fig. 15. Base of half-grown embryo showing differentiation of tissues at the root tip. × 235.
Fig. 16. Nearly mature embryo showing different tissues and the multicellular base of the suspensor piercing the integuments and reaching the testa. Cotyledons obliquely cut so as to mask the regularity of tissue. × 100.
Fig. 17. Haustorium-like region in the base of the suspensor. × 100.
Fig. 18. Cross section of seed showing the mature embryo and corrugated testa. × 75.